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General Science in the Junior High School.

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Perhaps never before has there been such a demand for the reorganization of secondary education as at the present. While much of the reorganization suggested is along administrative lines, no less urgently perhaps, comes the demand for a change in the subject-matter and in method; also there is a demand for economy of time and not infrequently for no patchwork and no repairs or changes of any kind but a whole new system. Without doubt, the junior high school idea involves some change at least, along all the lines suggested. We have already been cautioned not to get the idea that the junior high school is to be a strip off the old high school and a strip off the elementary school nailed together. Equally important is it for us to remember that it is not to be a high school, nor an elementary school nor a mixture of the two in equal proportions. It is to be a new school with new ideals and a new purpose. For this discussion, we shall assume the school system reorganized on the six-three-three plan and deal with science in the middle of these three groups or what is usually termed the junior high school and includes the seventh, eighth and ninth grades. The discussion will deal with such questions as: "How much science shall be offered and in what years? What shall be the nature of the subject matter? What shall be the method of presentation?

In what year shall the science work be begun? Already, we are told, the seventh and eighth grades are overcrowded with work and there is a demand for more to be added. This being the case, the problem of beginning science or any other high school subject in either of these grades, is by no means an easy one to solve. While we cannot dispute that these grades have enough work to do at the present time, we may well question whether the courses required are what they should be or whether they ought to give place for some other courses. Most of us are willing to agree that the

elementary school should teach the tool subjects, but should eight years be used for such instruction? The monotonous drill work often resorted to in the eighth grade not only is a loss of time, but actually has a detrimental influence on the boys and girls. Such subject-matter as the puzzles in arithmetic and the technical grammar with which the elementary school is often burdened during these grades, has little place in the life of a pupil in the grades. The adolescent period is a responsive period and much of the work given in the grades during this period is not fruitful enough of suggestion and activity. This is not a time when the student cares to rack his brain over non-essential material or to waste his time with uninteresting and practically valueless drill. He wants to see some reason for doing things, and results count. The lack of more vital subject-matter in the seventh and eighth grades undoubtedly accounts, in part at least, for the large numbers of pupils never seeing the inside of a high school building. A child at this age is curious and has a desire to exercise judgment. A period of exploration and self-discovery is being passed through. The boy wants to do things for which he can see need and from which he can expect to get results. He cannot be expected to find himself in monotonous and endless reviewing of subject-matter which does not appeal to him. He is a new being and he demands new fields and new opportunities. Is it any wonder that he wants to get into the active world outside? He almost deserves to be congratulated. The wonder is that so many survive.

We are gradually coming to realize that the end of the sixth grade marks a natural psychological division in the life of the child. Surely we shall not fail to realize also that this is an opportune time for the introduction of subjects which are new and full of meaning. As we have already said, the boy is a *new* boy; the girl is a *new* girl. Old things have passed away and new wants and new desires manifest themselves. The senses are active and alert and many natural instincts are prominent at this period. Many a student would find satisfaction and profit in the study of general science in this unusual period of his life. In many instances such study would furnish a new incentive for continuing in school. If we are to educate the student so that he can play the game of life successfully, then surely at this period when his whole being is so responsive, we ought to give him an opportunity

to learn the rules of the game, which, as some one expressed it, are only the "laws of nature." By beginning science in the seventh grade, we would not only enrich this grade but we could relieve the regular high school program also. This would afford an opportunity for the student to take some extra high school courses for which he otherwise does not find time in the four years of high school work.

My plea for science in the seventh and eighth grades is not made for the average students only. Many of these have survived in the past in spite of what we offered them. But how about the poor "unfortunate misfit" to whom an Irish schoolmaster in a Pennsylvania school district once said, "What God Almighty has not given you, I cannot give you. Take your books and go home." Should the student be sent home because he is not bookminded or because he does not readily accept what we have to offer him? Has he no right to something in which he is interested? If my own experience with boys studying general science in the ninth grade has taught me anything, it is that general science would be the salvation of many a boy in the seventh grade, were it offered him. There are many more like the "dullest boy in school" who, while playing along the roadside, with bugs, was found by his teacher. A little questioning on the part of his sensible teacher revealed the fact that the boy had an intense interest in bugs. She encouraged him, gave him some books to read and later he became a specialist in this line. Should this boy have been allowed to leave school because he could not learn arithmetic or because he could not spell or learn technical grammar? Is this an exaggerated instance? I think not. Did not Edison's teachers feel sorry for his parents? Was not George Westinghouse a problem because he persisted in playing truant and was he not often found around railroad yards? I know of a successful science teacher whose interest in science began when as a dirty, ragged urchin he accidently happened into a room where the falling of a penny and a feather in a vacuum was being demonstrated. According to his own testimony, that one thing made him want "to know more."

It does not seem reasonable that at a time when scarcely a line of human endeavor has not been completely revolutionized within a half of an ordinary lifetime, that we ought to be unable to hold our students in school and interest them in science study. Yet

such is the case. General science, we are told, came into the high school, largely as a result of the failure of the high school to get hold of its students for special science study. We have been plunging our students into special sciences for a few months and then wondered why they do not like it or why they learn so little science. We begin many other subjects when the pupils enter school and continue them through the grades and not infrequently into the high school, yet the subject which has to do with every phase of human activity at all times, we insist on giving the student in one or two years but only after the proper time for the beginning for such study has gone by. The junior high school presents a new opportunity for instruction in general science so that whether a student continues in school or not he may at least have a commonsense idea of the things about him. According to the testimony of many students, they leave school because they are not interested in what the school has to offer them. According to Mr. Ayres in his study of "Laggards in our Schools", retardation and elimination occur most often after twelve years of age when pupils are required to take up a "continuation of a wearyingly monotonous curriculum." If a student fails in a subject we say he is guilty of all and make him take the whole curriculum over again. The old Jewish Law had nothing on us when we consider this matter. Here is an opportunity to offer the student something different and general science because of its very nature has interest for the boy and girl at this period.

We assumed at the beginning of this discussion that the six-three-three plan of school was to be adopted. Whether or not this grouping of grades takes place, I believe general science should be begun in the seventh grade and offered in the eighth and possibly the ninth.

What shall be the nature of the general science course in the junior high school? First of all the course should be really *general* science. We have already insisted too much on the purity of science in the other science courses. Whether we will or no, we must face the fact that as a rule we are failing to hold students in school and according to the report of the Commissioner of Education for 1911, while most of the subjects were gaining or at least holding their own, the sciences were actually losing in numbers. This condition may be somewhat improved now but it is far from

satisfactory. According to Professor Barber, much of the distaste for science is due to our trying to put our research methods of pure science to work with the adolescent or the high school student. Surely if we have a lack of interest in science when every artery of the whole realm of our existence is pervaded by its application, so that our very mode of life is entirely changed, we are failing to make our students realize the value of science. Those who oppose general science on the grounds that it is not scientific knowledge, should tell us what is wrong with the special sciences that they are considered by so many of our students as something to be taken only as a last resort. The adolescent child needs information along the whole field of science. He is living in a world in which he is constantly observing phenomena which need to be explained to him if he is to live properly. These explanations do not require any one special science—they include them all. General science should be inspirational and should give an appreciation of the whole field and bring as much as possible into the experience of the everyday life of the student. We do not teach geography in order to turn out explorers, nor history to make historians and we should cease trying to teach science as though we expect every child who studies science to become either a physicist, a chemist or a botanist. The practical human side is infinitely more important than the specialist's side at this period. Does the average student who is given a quantitative experiment in chemistry even in the last year of his high school career become more scientific and will this scientific attitude carry over to the time when the school days have come to a close? We dare say, usually not. The problems of the active adolescent boy and girl are not problems of physics or chemistry or botany or any of the other special sciences. They are problems dealing with actual life and for the solution of these problems we cannot and certainly need not try to separate the sciences.

We should not as some suggest, retain in general science only what can be adapted at once to the life and experience of the child. The experience of the child may be used for a starting point; it should certainly not be made the end. There are many things we can enjoy after we know more about them and this means a wider knowledge and consequently a broader education. For example, we could hardly say that a study of some elementary astronomy could

be immediately or perhaps ever adapted directly in the life of the child but the subject is wonderful for developing interest and imaginative power. By all means we should give the child at this period a look into the great universe. He will never fail to become interested. General science is called by Dr. Caldwell, an "opportunity study." We may consider this opportunity as one for giving students who will never study pure science, an intelligent understanding of the common affairs of life and also as an opportunity to lead pupils into new fields of interest. If the course is made up of such subject-matter as shall take into account primarily the pupil, the course will undoubtedly be best for the science work which is to follow.

If we are to have science work in both the seventh and the eighth grades, what shall be offered in the seventh and what in the eighth? It is interesting to note that most writers on general science topics do not commit themselves on this point. It is evident that there is not general agreement among those who have tried to tell us what the basis should be. Some contend it should be primarily along biological lines first and the other sciences should be the basis later. Others take the opposite view. The facts are, there seems to be little more in favor of one than of the other. Both have been used with excellent results and as we have already stated, the work must be made general. There is no longer any ground for the contention that simple physics cannot be taught in the grades. The simple laws and principles of physics in the explanation of various phenomena, have been effectively used in various places as low as the sixth grade. We have in many schools physiography and physiology in these grades. Students of the high school and of the grades, tell us that these subjects are poorly taught, are losing ground and are really not justifiable courses in the grades. There seems to be no good reason why the fundamentals of physiography should not be taught in a good general science course. I have found a study of the air a very good starting point for general science in the ninth grade and this might as well be made a beginning topic in the seventh grade. I do not believe the subject of physiology, as usually taught, has any place in the junior high school. It is not desirable at this period to have the attention of the child called so much to the organs of his own body and the study of physiology rightly belongs in the upper grades of the

high school after he has studied botany, zoology, physics and chemistry. This does not mean we are not to study hygiene. The junior high school course in general science should be made strong in practical hygiene study. Some elementary bacteriology should be introduced early in the course in order to get the child aware of the causes of many diseases and of ways to prevent them. My experience has been that students are readily interested in the subject of bacteriology. First of all, of course, the child must be made to see the problems of hygiene and then the study will not only become interesting but very practical. A study of the sanitary conditions under which food is obtained always affords lively interest. In the study of the air, we have problems of hygiene such as, ventilation of home and school buildings and also of the dust content of the air with special reference to the live dust. Cultures of air bacteria and molds should be made. In the study of water, local conditions with reference to the purity of the water will constitute a problem along sanitary lines. Here methods for purification of water should be demonstrated and we have elementary physics but in terms of a practical social problem so as to enable the pupil to live more efficiently. The study of both air and water may be made the basis for certain lines of physical geography.

As nature study work, we can do no better than to acquaint the student with his friends in the animal, plant and insect world and of methods for protecting those which are friends. The pupil should learn to distinguish between useful and harmful birds and plants; also the ways to rid ourselves of our enemy pests in the plant, animal and insect world. Good examples are the rat and the detestable house-fly. What better opportunity could one want for again teaching hygiene! How is the house-fly harmful? Does he carry germs on his body? An agar culture will impress this on the student in such a way that he will have some incentive from the standpoint of health for fighting the fly.

General science should include considerable plant study. Why not introduce the child to the elementary principles of agriculture through the garden which is of such importance at the present time. The girl who said to me, "I am going to put some of these things we are learning into practice in my garden this summer" was getting science which was helping her to live better. The locality and the experience of the teacher will determine largely what the material to be used shall be and what the problems which

will arise. General science can be made to include physiography, hygiene, botany, zoology, physics and some chemistry. These should be used whenever needed to help the child to solve his problem whatever that may be. His environment needs to be interpreted and and his experience broadened and the wise teacher will find the subject matter of general science adapted for interpretation.

Having determined what our subject-matter shall be, what shall be the method of presentation? It is almost useless to say the work must be simply presented and must not be too abstract or technical. As in the case of the subject-matter, perhaps the aim of general science will help to determine to some extent the method to be used in presentation. Shall it be for preparation for future courses in science? Personally I believe not and I have tried to teach the subject as Professor Elhuff expressed it when some one asked him how he would teach general science in order to prepare the student for the subsequent courses in science. His reply was, "Teach general science as though the student never intended to take a more advanced course in anything. In other words, teach him how to live." Professor Coulter expressed the same thought when he said there is no need for giving any particular aim for general science. According to his view we are just to let general science do its part in the development of the child and broadening his experience which means real education and then there will be no need to be concerned about the subjects which are to follow.

There has been objection to general science teaching because, it is claimed, we are not teaching real science. I believe a scientific attitude of mind is important, but this, as some one expressed it, is only "trained common sense," and a practical social issue explained through the use of the special sciences just as they are needed, surely is a training of common sense and therefore a development of the scientific attitude. The spirit of inquiry is developed in the boy as he learns to explain his problems and as he gets a better understanding of his surroundings as a result of his study. Professor Tait says, "science aims at giving a common sense view of the world in which we live." "Method" says Professor Dewey, "means a way to a result, a means to an end, a path to a goal." He further suggests that general science has its justification in the "attempt to get nearer to the world in which the student lives and

away from he world which exists only for the scientist." Professor Judd, in his book "Psychology of High School Subjects" says, "the chief business of science is to train the student to see problems." He further adds, "We must find the means of arousing in the student the problem-seeking and problem-solving attitude. We cannot depend on ordinary life to cultivate either of these attitudes." He further says, "We must find devices which will arouse the problem-seeking attitude and we must then focus this attitude upon commonplace surroundings." If these men have the correct view, then it remains for us to find a way for teaching general science so as to make the student see problems; of making science fit into his world; and of explaining problems which the student encounters, by the aid of science, thus giving him a common sense view and an intelligent understanding of his surroundings.

How is this to be accomplished? There are those who contend that we must always begin with things with which the student is familiar and teach only what can be applied at once in the life of the student. But does the student or even the average adult see problems in everyday life? Usually he sees them only after they have been pointed out to him. Professor Judd says, "the unfamiliar presents obvious problems." He points out however, that we must not expect the unfamiliar to furnish us all our problems. The facts are that there are many unfamiliar and often mysterious phenomena connected with everyday life and it remains for the teacher to make the student see the problems and to make him want to find a solution. Not infrequently, too, the familiar and mysterious at first can be interpreted in the simplest experiences of the student. Certainly we should not, as has already been stated, limit our general science to what is already common to the student nor to what can be immediately used in the life of the student. We must lead him into new fields in order to broaden his interests. In this way general science can be made a factor in the life of the student in helping him to see his problem and to solve it in keeping up and broadening his experiences and interests; and in leading him into new fields of activity some of which may have a special charm for him.

The so-called project method seems to be especially suited for this purpose. The term project has been given various meanings when applied to teaching. It has been used when referring to a simple

experiment which would perhaps not require a half minute to perform and again it has been used to apply to six-months work in some general field. The facts are that most things we do are projects and whatever differences of meaning may have been given to this term as a teaching unit, there is somewhat general agreement that it means something fairly definite to be done or in other words that project-teaching is problem-teaching. A project has been generally defined as "an undertaking of comparatively limited scope, in which a pupil or a group of pupils or an entire class under the direction of a teacher, do some definite work in actually making something or in observing or interpreting some phenomena or process." A project then may mean the construction of something, the growing of some crop or animals or it may merely mean the finding out or understanding the reason for certain phenomena. A need or a desire for finding out or doing should be the basis and so far as possible should be done by the student. This method puts purpose into teaching and it will be remembered that lack of purpose is one of the main charges against the work of the seventh and eighth grades as it has been in the past. If the problem has been fairly grasped by the student he begins to inquire—to try to find out something about it. The fact that he wants or needs to know becomes an incentive for his study. He draws from every available source and here we have an example of how impossible it is to differentiate the special sciences for this purpose.

As stated before, the project should originate so far as possible with the student but he must not be expected always to find problems without assistance. A lecture or a demonstration by the teacher, a conversation between teacher and student or something read or observed by the student may at any time produce a problem which may best be developed as a project. No teacher of general science should attempt to follow such a set schedule that he cannot at any time change his plans so as to help solve a problem even should such solution require days or in rare cases even weeks to solve. Why should we conform to a set schedule? It is better, far better that the student be given help when he needs help in the solution of a practical problem. There may be times when a whole class could profitably carry out a project—at other times groups of students may work on different projects and occasionally some students may work individually. In every case the class through dis-

cussion, should get the benefit from whatever has been done. Taking care of the school grounds might well develop into a class project. Suppose some student asks, "Why does the wind blow and what is wind anyway?" Instead of an answer in a few words, which does not really mean anything to the student, a study of the air, with particular reference to convection as a result of temperature and pressure, may be made. Not only will the answer to the boy's question finally be effective, but the principle of the wind systems of the whole world can be developed and understood. With some simple demonstrations such as showing the expansion of the air when heated and convection in air and in water the student can also effectively be taught some principles of physiography. There will then no longer be the disconnected bits of knowledge regarding winds and other weather phenomena, but general relationship which will have meaning and be much more readily understood.

In order to get new projects, it may prove very helpful and suggestive at the proper time to give the students an opportunity to make known something about which they want to know more. If this is done in writing, the teacher can at least have a basis for further projects and can guide particular students along the lines they have indicated or lead them into other fields if in his judgment the one selected is not wise. Another method the teacher may use occasionally is to put before the student a list of suggested experiments and let them select from the whole, the ones which appeal to them most. Here again the teacher can select the ones which seem to appeal to the larger portion of the class. It is evident that the teacher must exercise tact and judgment if this method of selection is to be successful.

No list of projects should by any means be made and then slavishly followed nor would the list which might be used in one school be applicable as a whole to another school. Following is a partial list of projects, some of which would be adapted for any school in any locality:

Raising of some crop on a plot.
Raising of stock.
Construction of some sort (concrete walk, post, etc.)
Making of furniture.
Planting trees, shrubs, flowers, etc.

Study of fireless cooker and perhaps making one.
Production of sanitary milk.
Water supply.
Baking bread.
Canning fruit.
Testing seed for neighboring farmers.
Making pictures, lantern slides for class use, etc.
Principle of refrigeration.
Principle of the steam engine. (for boys.)
Operation of the telegraph.
Wireless telegraphy.
Why a stove "draws."
Study of different fuels.
Why water puts out a fire.
Distillation of wood.
Purification of water, (different methods.)
Why food cooks so slowly at high altitudes (cook some potatoes under increased pressure and under reduced pressure).
Testing for per cent of butter-fat.
Principle of the siphon.

Manifestly, this list might be made much longer but this is not intended as a complete list but merely as a suggestion as to the possibilities along the line of project teaching. While this method offers such possibilities that it seems we can hardly be too optimistic about it, yet a word of caution is perhaps in order. No method would result in a more miserable failure than the project method unless used skillfully. It is evident at once that a teacher must be energetic, tactful and resourceful. Unless already familiar with this method of instruction in science no teacher ought to plunge headlong into it. A much wiser course to pursue is to take it up gradually. Many things in science can be and in fact should be, taught as just disconnected information to be used whenever needed. With subject matter well chosen and good judgment exercised on the part of the teacher this method can soon be used effectively with the adolescent boy and girl who are so anxious to get results from what they do.

General science in the junior high school is not to be considered a cure-all nor as a prevent-all. In the reorganization of our program of studies for the student of this period we are endeavoring

to give the student something which will appeal to him and which will make him see some reason for continuing his work in the high school. General science in its manifold phases has in it something which appeals to almost any and every student if he can be properly led to see that it means that he will be better able to solve his life problems if he has a knowledge of the things about him. If we are to judge at all from what has already been accomplished by general science in the ninth grade we have every reason to believe that if the subject matter is properly organized and properly presented, the seventh and eighth grade students can be greatly benefited whether they continue in school or drop out at the end of the ninth grade and I believe general science offers an incentive for more than one boy to continue his studies.

Some Objections to Project Teaching.

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Notwithstanding the enthusiasm manifested for the project method of teaching general science, there seems warrant for entering a few words of protest and caution concerning it. The project seems to be simply a method of procedure—a thread upon which various experiments and investigations may be strung. From the nature of the project these things are often totally unrelated to one another except for the thread that holds them together. In one such project recently suggested in a journal for teachers, I note references to radiation, conduction, combustion, insolation, manufacturing processes, commerce, agriculture, zoology, botany, biography, bleaching, dyeing, acids, alkalies, soaps and the compound microscope. If this is a fair sample of the project method, those critical first year science teachers who insist that general science is a "hodge podge" are not far out of the way. Nearly all the items in the list are excellent subjects for study but not in the purely fortuitous order in which any project arranges them.

What the student of general science needs first of all is a thorough grounding in general scientific principles. With such a foundation it is possible to build up a superstructure of the special sciences, singly or in combination. At this stage, the project is

not only permissible but actually desirable since it tests the pupil's knowledge in many fields and demonstrates his ability to use such knowledge in solving the new problems that arise in every day life. To adopt the project method earlier, is to reverse logical procedure by requiring the pupil to study results and completed processes before he has any adequate conception of the causes. The pupil must be taught to creep before he can walk, much less fly.

A second objection to the project method is that it leads to talk about things rather than to a study of the things themselves. It necessarily calls for much consultation of reference books with a further increase of the child's store of second-hand and hear-say information. I do not mean to depreciate the use of reference works, but I question whether a child of twelve is as well employed in digging scientific knowledge out of a book as he is in studying some scientific problem or principle at first hand. The project method, also, is likely to result in much ineffectual talk and useless dialogue, taking time that might be more profitably devoted to something else. If general science is ever to be, as its friends claim for it, an introduction to the special sciences, it must adopt the laboratory method and bring the child into contact with actual things. In no other way can we develop in our people that originality and independence of thought and action so necessary to continue this a progressive nation. The child as he comes to the high school, is altogether too dependent upon books. We must encourage our instructors in science to get away from the lesson-hearing, tell-it-to-me, watch-and-see-me-do-it phase of teaching and adopt the problem solving method. In general science, especially, the student is better employed in studying scientific principles and finding their applications in various phases of existence about him than he is in trying to discover and understand the principles involved in some complex subject.

A friend of the project method of teaching recently advocated it because, among other things, it "seldom ends in a complete, final or absolutely finished conclusion." This, however, appears to be the very best reason for objecting to it. If the study of science is not concerned with facts and does not result in very definite conclusions, it is scarcely entitled to the name. Even to call it general science does not warrant us in being satisfied with general conclusions.

How the Experience of Physical Geography may be an Aid to General Science.

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It may be helpful to the friends of general science to review the experience of physical geography as a high school science during the last twenty-five years. The most famous educational report that has been presented in this country was the report of the Committee of Ten of the National Education Association. This report appeared in the early nineties, and has been regarded as the most epoch-making document on education during the present generation. We are now hearing a great deal about the reorganization of the school curriculum. The report of the Committee of Ten, twenty-five years ago, was intended to accomplish precisely the same thing, namely, a reorganization and improvement of education in elementary and secondary schools. The most eminent and competent educators of the United States served upon the various sub-committees.

PHYSICAL GEOGRAPHY MADE THE INTRODUCTORY HIGH SCHOOL SCIENCE.

The significant thing for our present purposes is that by practically unanimous consent the Committee of Ten recommended physical geography as the one preferred science above all others for the first year of the high school course.

This committee drafted four standard courses of study, namely, classical, Latin-scientific, modern languages, and English courses. In every one of these courses, geography was recommended as a required study, sharing this preference with English, algebra, and history. The general committee had no particular interest in any one science above another, but as the result of their many conferences they selected physical geography as being best fitted of all the sciences for the introductory science of the high school. This endorsement by such an eminent body of educators started physical geography off with most excellent support. Very shortly, text-books of a more scientific type than their predecessors appeared and physical geography was rapidly introduced into nearly all high schools, being offered as a rule in the first year.

Those who favored physical geography thought mainly of its content when they chose it for the introductory high school science. They knew that the study dealt with our immediate environment, the air, the earth, and the water. A large portion of the phenomena studied are open to easy observation. Weather and climate can be studied anywhere. Almost every locality furnishes opportunity for studying the process of weathering and erosion. Stream work, soil formation, lake shore or seashore erosion and deposition, springs, ground water, and many other natural phenomena may be seen in almost any locality. Expensive microscopes or other apparatus were not required. The great laboratory of nature lay around the school building. Quite naturally the Committee of Ten and school men generally thought physical geography an ideal first year science for the high school.

A few years after the appearance of the report of the Committee of Ten, twenty-five per cent of all high school students in the United States were reported to be studying physical geography. This means that during the four years of high school almost all of the students in the high schools of United States studied this branch. With such high educational endorsement as the study had received, and with such a cordial reception from the school men, it would seem that physical geography should have proved successful. Yet to-day we find that scarcely one-half as high a proportion of high school students are studying physical geography as were studying it twenty-five years ago.

DECLINE IN HIGH SCHOOL SCIENCE MORE APPARENT THAN REAL.

Of course, it may be pointed out that all of the sciences have *seemingly* lost ground during this quarter century. As a matter of fact, I do not think they have lost ground to anything like the extent that the statistics would seem to indicate, if we do not look below the surface. It must be remembered that twenty-five years ago a science was usually studied for one-third or one-half of a year. The old series known as Steele's Fourteen Weeks in Chemistry, in Botany, in Zoology, and in other sciences were among the most widely used text-books. These were superseded by Steele's Popular Series of science books, but these also were designed for a single term of school, sometimes a third of a year, sometimes a half, but never a whole year. Now it is customary to carry physics, chemistry, and biology throughout an entire year. Twenty-five years ago a student might take botany the first term of a school

year, physics, the second term, and chemistry the third term, all within one year, while under present conditions he would probably pursue one science throughout a year. Plainly, then, we can not compare the reports regarding the number of students electing science studies now with the reports of those earlier years; and if it is discovered that seemingly there were more enrollments in science studies in the nineties than there are now, we must look behind the figures and ascertain how long the students of the earlier years pursued each of these sciences. This, however, is merely a digression intended to caution those who are unduly pessimistic about the declining popularity of science studies in the high schools. Probably sciences have not gained in popularity during these years but I am sure they have not lost in popularity so much as the reports of the Commissioner of Education might lead us to believe.

WHY PHYSICAL GEOGRAPHY PROVED DISAPPOINTING.

However, it is clear that physical geography has not met with the success that its friends of the nineties anticipated, and because it has not proved to be so satisfactory as an introductory science as was expected, there is now under way an active movement to substitute some other science as the introductory one. The science which is most in favor is usually called General Science, First-year Science, or Introductory Science. This study has received most vigorous and enthusiastic support from many sources and has been, or is being widely introduced into the schools of the country. Also it has met with some vigorous opposition, although the support has apparently been much stronger than the opposition.

It is not intended in this paper either to oppose or to support general science but rather to point out a lesson which may be gathered from the experience of physical geography. The committee that unanimously recommended physical geography as the required science in the first year in all the standard courses were thinking mainly of the fitness of the subject itself. They did not realize then as we do now that there were practically no teachers in the country who had been trained to teach physical geography according to modern ideals. This branch can not be successfully taught unless a considerable amount of field work is done and is made a regular part of the course. If made strictly a text-book and in-door study it has lost more than half of its potential value.

Doubtless the supporters of physical geography believed that if a demand for teachers existed, the normal schools and colleges would prepare the teachers. But, as a matter of fact, this was not done. Most normal schools can not be expected to do very much toward training science teachers for the high school because their function is primarily to train teachers for the elementary schools, and in those schools very little science is taught.

Only a comparatively small number of colleges offered instruction in physical geography until the last fifteen years and those colleges could train only a small fraction of the physical geography teachers demanded. The out-of-door work which is so essential to the success of physical geography was not undertaken in any large degree, partly because there are many difficulties in the way of doing it, and still more, because very few teachers felt themselves justified in taking classes into the field to study things which they themselves did not understand. The inevitable result was that physical geography was made almost solely a book study and a memory study, and failed in a large degree to give the scientific training which was intended.

Little by little this failure was recognized by the school principals and superintendents. They saw that physical geography was being taught in a mediocre way, mostly by teachers who had not been trained in the subject. If they sought trained teachers they found them hard to secure, but, as a rule, they did not seek them. Commonly the physical geography classes were assigned to the new teacher who had a vacant period. I have visited schools where the music teacher was conducting the class in physical geography; in another, where the stenography teacher was doing it, and frequently where teachers of English, history, or Latin were doing it; and practically every one of these teachers admitted that she (or he) had had no preparation for the work and therefore, would not profess to be competent; she usually regarded her teaching of the subject as a make-shift soon to be remedied. The situation was usually remedied by taking the next new teacher who came into the school, and who was equally unprepared. Correspondence with school-men in nearly all parts of the country leads me to believe that this has been the practice almost everywhere. I have visited scores of schools in Wisconsin and outside and have only occasionally found physical geography taught by a teacher who had made

anything like an adequate preparation for the work. Under such conditions, success is impossible, and physical geography, after a quarter century of trial is now on the defensive and in many schools is being replaced by general science, agriculture, or some other branch.

THE OPPORTUNITY AND THE PROBLEM OF GENERAL SCIENCE.

Just now general science is being given its trial. Everyone of us who are interested in science teaching wishes general science to yield its highest possible educational returns. Whatever science is taught in the high schools, we want it to be well taught and we want it to win support. It is particularly important that the introductory science shall be well taught, for one of its purposes is to inspire students to continue on in scientific studies. General science is valuable more for the appetite which it creates than for that which it satisfies. Its greatest function will be to open the pupil's mind to the world of science and to make him hungry for more. How can this be accomplished? Surely not by the procedure which was employed in the case of physical geography, entrusting its teaching to the young, untried, untrained teacher. General science will prove a disappointment, unless school principals employ competent teachers. A teacher ought to have a very broad preparation involving some knowledge of nearly all of the recognized departments of science. The universities do not at present encourage their students to take more than about two branches of science. The tendency of university instruction is to concentrate upon one major and about one minor line of study. This plan tends to make physics teachers or biology teachers or geology teachers, but only in an imperfect way does it tend to make general science teachers. In a large gathering of science teachers of Chicago a year or two ago this question was asked of one of the leading advocates of general science in this country:

"What do you consider an adequate preparation for a teacher of general science?"

The answer was, as I recall, "I should wish a teacher of general science to have had in a good university, at least the following: a course in physics, in chemistry, in botany, in zoology, in physiography, in bacteriology, in physiology, in astronomy, and in mineralogy. Surely we will all agree that we should like to have general science teachers thus broadly equipped, but where are such teachers

to be found. Where shall we find teachers in any considerable numbers who have had one-half of this preparation? The fact is that nowhere are teachers in large numbers being prepared for general science teaching, and the result is that in scarcely one half of the schools where general scinece is taught is it in the hands of a person who considers himself or herself prepared to do the work. Enthusiasm will accomplish a great deal. General science is in itself interesting, and even with fair teaching, may succeed quite satisfactorily. Most of the general science classes that I have visited were thoroughly enjoying their work and many of the teachers, though inadequately prepared, were putting a degree of enthusiasm into their work which carried it along and won quite creditable results. Nevertheless, it is true that in many quarters the expectations entertained with reference to general science are not being realized. I have at hand some forty letters from teachers in one of the states where general science has been tried for five or six years, and the general tone of the letters is one of disappointment. There is danger that general science will repeat the history of physical geography unless school men shall demand of the schools that train their teachers an adequate preparation for science teaching. If the principals will insistently demand that the training schools and colleges train teachers for general science, that demand will be in part met.

THE NEED OF QUALIFIED TEACHERS.

The course before the friends of general science now is less to enlist support for the study in the high schools than to secure the training of teachers to handle the study. If this is accomplished, general science may escape the experience of physical geography and may prove worthy of the confidence which thousands of school men are now placing in it. But without competent teachers no branch of study can permanently succeed. In the competition for time between the various studies in the high schools the weaker branches will be crowded out. As I see the problem, there are two important steps to be taken in the field of general science; first, a closer approach to a standard course, that is, a better agreement as to what constitutes general science; and, secondly, a concerted, nation-wide effort to secure teachers trained to handle the study. Neither of these is a step easy to accomplish but much can be done toward its accomplishment if a vigorous effort is made.

Student Interest in Subject Matter.

HAROLD LYON, HIGH SCHOOL, MEDFORD, MASSACHUSETTS.

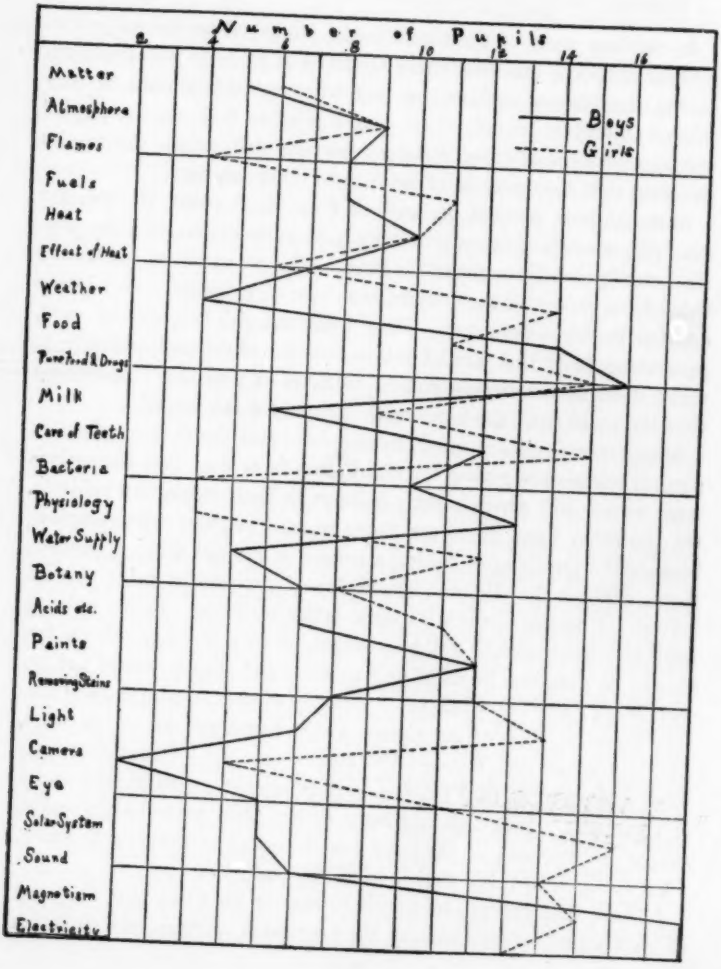
In reading many of the recent books published on the subject of general science I find that there seems to be little or no agreement among the various authors, on just what subjects should be considered in such a course. Last year I tried to find out the pupils' opinions of some of these different subjects and submit the results thinking that they may be of interest to other teachers.

Some authors present the subject from their point of view, for example, one whose interest is mainly physics, emphasizes the physical standpoint throughout his book. The more recent authors, I think have presented the subject from two view points, which in my opinion is the correct one. First from the child's point of view, presenting facts that are of interest to the child and secondly to make them as practicable and as valuable as possible. Something that the child can take home with him and make use of.

Many special science teachers complain that the courses given in general science are giving the child some facts that they themselves want to use and which rightly belongs to their respective subjects. On the other hand there are those science teachers who complain because the pupils after taking a course in general science, come to them, without the slightest knowledge of the science principles involved. I cannot agree with these latter teachers. In my opinion general science should not be a stepstone to any other science but should be complete in itself and so arranged that it would not interfere with any other subject. General science does stimulate further interest. Out of my classes which numbered 93 at the start, 32 disappeared and I ended the year with 61. I found that only 23 of these were to take further work in science, 18 in physics and 5 in chemistry. How this compares with a class never having taken general science and of the same size would be interesting to know. I am inclined to think that it would be the same.

I think that general science is primarily for those that drop out of high school before finishing the four years, or those who do finish

and do not take any other science. I know that the 23 in my classes who are to take further work in science would certainly have chosen physics or chemistry if they had never taken general science. In my classes there are 49.2 per cent girls and 50.8 per cent boys.



It occurred to me that it might be of interest to find out what subjects presented during the year were of greatest interest and how boys and girls agreed on the same subjects. I made out a list including all subjects touched upon and asked them to check those which interested them. The subjects are below and are really subject headings. They must not be taken literally for as much as possible was taken up under each heading.

In touching upon these subjects (see chart) I made them as brief as possible covering everything of interest and trespassing on no one's territory. In plotting the results I find some very interesting differences of opinion among the boys and girls. Matter and atmosphere were of about equal interest. Flames brought the girls behind the boys. With fuels, the girls go ahead of the boys and heat brings them together again. Curiously the effect of heat showed a drop for both. Fourteen girls were interested in the weather to four boys. The question of foods brought both somewhat nearer but the boys going ahead of the girls. Pure foods and drugs seemed very popular to both and both showed a moderate interest in the milk question. Teeth and the care of them brought both up again with the girls ahead of the boys. Bacteria and hygiene appealed strongly to the boys but strangely to me they dropped below the girls in the study of the water supply. Botany seemed to be of equal interest, while chemistry appealed much more to the boys than the girls. Removing stains naturally held the girls above the boys. The camera brought both down again with the girls the more interested. The human eye brought the interest up a little with the girls in the lead. The sun and the solar system showed the girls in favor. Sound brought the boys up and the girls down. In magnetism and electricity the boys are naturally ahead of the girls and they still remain there in the subject of physiology.

In the chart the figures at the top represent the number of pupils signifying an interest in the subjects which are listed at the side. Some pupils of course only showed interest in one or two subjects, some none at all, while others seemed to find something interesting in most all of them.

The First Year—For the Eighth Grade—of a Two Year Science Course for the Junior High School.

HARRY A. RICHARDSON, JUNIOR HIGH SCHOOL,
GRAND RAPIDS, MICH.

This article is the result of work pursued in a course in the organization of science in the high school. It was suggested that it might be of sufficient interest to people in education to warrant its being published. Part of the material in this outline has been worked out in regular class work, and part of it has been prepared for future use. Part of it, therefore, has been organized from the practical standpoint, and part from the theoretical. It is now what seems to be the best outline for work in the particular schools in which I am teaching. The sub-topics "projects" and "problems" have been selected from various text books, outlines, and my own work.

This course is being prepared for the eighth grade of a junior high school, that I think is fairly representative of the general conception of such a school. It occupies a large building by itself, and is made up of the seventh, eighth, and ninth grades.

Although I have been in the city of Grand Rapids, several times, I am not as well acquainted with the community in which this school is located and the home life of the pupils of the school as I should like to be before outlining a course of study such as this; for I firmly believe that the organization of a science course should first of all consider the home environment of the pupil for whom it is intended, and then see that the topics covered by projects, problems, experiments and observations are more or less closely related to his common or life experience.

I think all the work should be organized around a few large, outstanding, unifying topics. General science has been called a hodge-podge because it dealt with such a variety of fields of knowledge, and has also been called illogical. As a rebuttal to the latter point, Parker, in "Methods of Teaching in High Schools" points out that

if the pupil keeps the problem in mind—regardless of the field from which it was taken—searches for evidence, evaluates it carefully, rejects the irrelevant, applies the relevent, and formulates his conclusions and verifies them, he is being logical in the highest sense. General science does truly try to break away from the highly organized, logically arranged subject matter that is the result of the working of an adult mind, and which only an adult mind could be expected, with continuity of interest, to follow. It strives to psychologize the material studied, adapting the selection and presentation of work to be covered to the age and capacity of the pupils for whom intended. But even though we keep these thoughts in mind the greatest benefit will result by having the problems clearly related to some large unifying topic, which will serve as a justification or aim or motive for dealing with them.

Although I have never had the privilege of doing so, I think the best way to teach general science is without having the pupils all own the same kind of a text book. The course should be carefully organized and outlined. There ought to be a library of different science text books, books on scientific information, biography of scientists, scientific magazines and periodicals, with a laboratory equipped with suitable chairs, tables, and simple apparatus, and for the projects to be worked out from these—it seems to me this would be the best way to teach the subject.

But as it will be impossible to secure many of these conditions immediately in this school, it will be necessary to choose a text book which will ensure a source of information and reference to every pupil. A text will be used that will be fairly adaptable to the conditions of the school.

It has been decided that in the eighth grade there shall be three recitation periods per week, required of all pupils.

Due to lack of room at the present time for doing otherwise, the experiments will be largely demonstrational. After the beginning of the term and the pupils have become somewhat accustomed to the manner of doing, groups of pupils may be asked to do for the class the demonstration experiments they are capable of doing.

Pupils will often be asked whether they try to perform experiments for themselves at home, or to make use of facts and knowledge gained in the course.

In this school the shop work for boys and domestic science work for girls is well provided for, and many opportunities will be seen

and used to correlate the work in general science with that in those subjects.

There will also be points of contact with arithmetic, geography, history, and physiology which will be utilized to vitalize both the science and the other subject.

The pupil will be required to keep a record of the experiments and observations. These will not be of the old type of formal, exact, hate for science producing type. The pupil will be allowed considerable freedom as to the manner in which he makes an honest, true, record or statement of the work done as experiment, assignment or observation.

Without doubt, it will not be possible to cover all the work here outlined in the year of work in the eighth grade. The things that will determine what parts shall be covered and which left, will be the probability as to which topics will be of greatest benefit to the greatest number of pupils required to take the science in the eighth grade, and the probability as to which ones had better be left for a more complete treatment in the elective course that is to follow this one in the ninth grade.

TOPIC 1. COMBUSTION.

Sources of heat.
Kinds of fuels.
Project: Making a bonfire.
    List of questions about bonfire.
    Why the fire burns.
    Lesson on elementary chemistry.
        Elements and compounds.
    What becomes of wood when burned.
Oxidation.
    Why stones not used for fuel.
    Heat produced by oxidation.
Project: Making a thermometer.
    Effects of heating.
        Water heats slowly.
Project: Thermostat.
    How heat travels.
    Ways for heating a home.
    How science room is heated.
Project: Study of a chimney.

What smoke is.
How these things were formed.
How illuminating gas is made.
Properties of illuminating gas.
How gas is made in Grand Rapids.
Study of candle flame.
Study of Bunsen burner.
Carbon dioxide.
How produced.
Body fires—relation to physiology.
Control of fires.
Losses from fires.
How to prevent them.

TOPIC 2. WATER AND ITS USES.

Three forms.
Changes from one to another.
Relation of heat to these changes.
Changing water to steam.
Evaporation.
Ice machines.
Changing vapor to water.
Condensation.
Dew, rain, frost, snow.
Distillation and applications.
Transpiration.
Influence of bodies of water on climate.
Relation to geography.
Fruitbelt of Michigan.
Composition.
Analysis.
Synthesis.
Water supply and sewerage disposal in Grand Rapids.
Source of water.
Impurities.
Filtration.
Health conditions before and after filtration.
Water system.
Sewers.
Various methods for disposal.
The one used in Grand Rapids.

Industrial uses of water.
    Water a solvent.
        Relation of this to plant and animal life.
    Uses in industries.
        Relation to geography.
    Mill ponds and dams.
    Water pressure.
        Arithmetical problems.
        Effect on construction and operation of submarines.

TOPIC 3. THE AIR AND THE WEATHER.

Does air occupy space?
Why kick foot ball farther inflated than empty?
Does air have weight?
    Meaning of weight.
        Biography of Sir Isaac Newton.
Determine weight of air in class room.
Air pressure.
    Project: Common pump.
        Meaning of pressure.
        Problem: Barometer.
            Biography of Galileo and Torricelli.
            Story of making first barometer.
Distinction between weight and pressure.
Moisture in air.
    Effect on weight of air.
    Relation of temp. and amount of moisture in air.
    Dew point.
    Dew, frost, rain, snow.
Air pressure and winds.
High and Lows.
Weather map.
    What designed to show and how it shows them.
    How forecasts are made.
Rainfall.
    Map.
    Importance of rainfall.
Composition of air.
Impurities.

TOPIC 4. SOME FURTHER APPLICATIONS OF SCIENCE TO THE HOUSEHOLD.

Bacteria and food.
Clothes and how they protect us.
Household chemicals.
Bleaching, bluing, starching.
Dyes.
Baking powder and soda.
Yeast and fermentation.
Metals used in the home.
Oils, paints and varnishes.

TOPIC 5. LIGHT AND ITS BENEFITS.

Why thing are visible.
Intensity of illumination.
Measuring the light.
Reflection.
Refraction.
Color.
Photography.
Artificial lighting.
Benefits of light.

TOPIC 6. WORK AND ENERGY.

Meaning of work; of energy.
Work by running water.
What is a machine?
Classes of machines.
    Examples of each class.
Study of engines.
    Steam engine.
        History of steam engine.
        Biography of James Watt.
        Story of steamboat.
        Story of locomotive.
        Steam turbine.
    Gasoline engines.
Relation of heat to mechanical energy.

TOPIC 7. MAGNETISM AND ELECTRICITY.

Frictional electricity.
A magnet.
Earth magnetism.
    The compass.

A battery.
    Kinds of batteries.
Current electricity.
    Heating effects.
        Household appliances.
Chemical effects. Electroplating.
Magnetic effects. Electromagnets. Electric bell. Telegraph.
    Motors.
Induced currents. Dynamo. Telephone.

TOPIC 8. NATURE'S BALANCE OF LIFE.

Meaning of term.
    Clover—rabbit—fox—wolf—man.
Overproduction.
    Potatoes.
Limiting conditions.
Why some forms stay, others do not.
Artificial selection.
    Biography of Charles Darwin.
    Good seed.
Germination.
Soil as source of plant food.
    Subtraction, and addition.
Why a plant needs water.
How water rises through the soil.
How liquid goes from cell to cell.
Food factories for all life.
    Leaf structure.
    Light and chlorophyll.
    The sun the Great Energizer.
        Relate to Topic 6.
Air for plants.
Public parks and city trees.
Birds, their food in relation to balance of life.
    Migration in relation to balance of life.
    Protection.
Plant fertilization.
    Structure of flower.
Seed distribution or dispersal.
    Seed of burdock in relation to balance of life.

A Communication.

EDITOR GENERAL SCIENCE QUARTERLY:

I trust that you will find many teachers endorsing your position regarding the differences between elementary science and general science expressed in the November number of the QUARTERLY. The whole subject of general science is still so new that our ideas with reference to it have not had time to crystallize. It is likely that many changes will have to be made before we can expect the study to be as well organized as some of the special sciences, but by taking thought in advance it may be possible to avoid some of the pitfalls into which we might otherwise flounder.

First of all, it seems to me, it is most important to emphasize the fact, which you have already indicated, that the presentation of the elementary parts of the special sciences cannot be regarded as constituting a course in general science. A real course in general science it seems to me, should be concerned with the general principles surrounding or underlying all science. The uncertainty in which the whole subject is at present involved is reflected in our text-books from which it would appear that even the authors themselves are far from agreeing as to what should constitute such a course. A number of excellent text-books now available are founded on one or more of the special sciences, but in my opinion, if general science, as distinct from nature study, commercial geography, and elementary science, is to succeed, it must very soon decide upon certain fundamentals and shape its course accordingly.

The demand for a course in general science is due to a variety of circumstances, but from the viewpoint of the high school, at least, it will best serve its purpose if it provides an introduction to the special sciences. There is no question but what the teaching of such sciences in a large number of schools has become so technical as to fairly demand an introductory course of this kind. But the course contemplated does not imply one consisting of an equal number of pages devoted to the elements of, say, physiology, physiography, botany, zoology, physics, and chemistry. It should, instead, treat of the principles upon which all these are based. What

these principles are may need considerable investigation to determine, but the sooner we set about the task of discovering them, the sooner will the general science movement be generally recognized as worthy of support.

Having decided what subjects should constitute or form part of the course the next step should be to induce teachers to adopt the laboratory method of presenting it. A good many otherwise intelligent teachers appear to be a bit afraid of a study that requires something actually to be done instead of talking or reciting about it. But the student needs an introduction to the methods of the laboratory and an understanding of the significance of an experiment quite as much as he needs the store of facts gained thereby. Fortunately most of the fundamental principles of science can be taught in an ordinary class-room equipped with water and gas, with materials easily obtained from the nearest kitchen and drug store. Even the beginning teacher should be encouraged to adopt this method. To make the course mainly recitational, or even to make it a course in observing experiments performed by the teacher is almost certainly to defeat its own ends and soon reduce it to the position of certain of the special sciences which through similar treatment are now obliged to fight for even a minor representation in the high school curriculum.

Above all, the course should be kept simple and within the comprehension of children not yet in their teens. Complicated apparatus, abstruse facts and the technicalities of commerce and manufactures have no place in such a course and should be rigidly excluded.

The special sciences are frequently charged with lack of practicality, indefiniteness of aim, poor organization, and a failure to correlate with other studies and their waning popularity in some sections is attributed to these defects. There are indications, however, that such imperfections are to be remedied and that science in time will be well organized and thoroughly correlated. This highly desirable state of affairs will be certainly advanced if general science, at the outset, so shapes its course that the more technical sciences can be built upon it.

WILLARD N. CLUTE.

Joliet, Ill., Jan. 3, 1918.

Food Conservation Exhibits for Teachers.

WILLIAM GOULD VINAL, THE RHODE ISLAND NORMAL SCHOOL.

Teachers have an important part to play in the winning of the war. Many of them feel the tremendous power they have at hand for carrying the message of conservation to the people through the children. Some have already brought into their teaching, incidental to language lessons or as a part of general science, the facts of food conservation. An exhibit was held at the Rhode Island Normal School on January 12, 1918, under the auspices of the Rhode Island Science Teacher's Association and under the direct supervision of the writer, to facilitate the exchange of these ideas. There was great ingenuity displayed in preparing material and it is felt that the readers of the QUARTERLY who were unable to attend the exhibition might like a brief resume of the results.

Direct aid was obtained from the State Federal Food Administrator, the Extension Department of the State College of Agriculture, and the Director of Home Economics for Rhode Island. An article printed for the United States Food Administration entitled *Graphic Exhibits on Food Conservation at Fairs and Expositions* is very suggestive for such work. Commercial exhibits were not combined with the teachers' exhibit at this time.

A list of some of the important projects will show the possibilities with the general unit *food conservation.*

Range of prices of sugar, potatoes, etc. during the period of the Revolutionary War, Civil War, etc.

Food obtainable in Massachusetts 1621-1629 and what they lacked.

Pioneer provisions in Alaska and what they now produce.

Food of the Romans and what foods were unknown to them.

Food on board the Santa Maria.

How to live on 24 cents per day.

Animal products of Narragansett Bay that we do not eat and ought to.

What the colonist ate that we neglect.

Food of the Narragansett Indians.

Help our boys save coal.

For meatless days.
Save soap.
Use more corn.
Why not send corn abroad.
Uses of sour milk.

The rural schools of Smithfield and Stillwater had been doing considerable in the line of food conservation. They served a Thanksgiving dinner to their parents, teachers, and the superintendent. For the exhibit they worked upon the so called Hoover Lunch Box. All sorts of combinations were worked out and then the four best, as judged by the children themselves, were sent to the Normal School.

An exhibit from the city schools, which should be spoken of was prepared by the children of the John Howland School, Miss Mary Williams, teacher. Every point was illustrated by colored pictures which the children had cut from advertisements in Good Housekeeping and other magazines.

The correlation with drawing was shown by the making of posters by the Normal School Classes under the supervision of Miss Marie Stillman. The possibilities in history, as suggested by the project headings, was enthusiastically dealt with by the Seniors, under the leadership of Mrs. Walter Stokes Irons. Professor R. M. Brown had geography material which pertained to the point. A world map to show the production of sugar gave opportunity for many to realize the part that the central powers had held in this industry. The importance of corn was shown in the oils, starches, sugar, syrups, gums, etc. exhibited by the Corn Products Refining Company.

Miss Adelaide Abell of the Technical High School prepared an exhibit to show what the soldiers need; what we can use in place of these things; and a wonderful meal for 22c. The following are recipes for making the things included in the meal.

CREAM OF PEANUT SOUP.

2 cups milk	1 slice onion
2 tablespoons peanut butter	1 teaspoon salt
1 tablespoon cornstarch	Pepper

Cream cornstarch and peanut butter, stir into heated milk. Cook until creamy and add seasonings.

SALMON LOAF.

1 cup fish
1 cup left-over bread or cracker crumbs
1 tablespoon chopped parsley
Pepper
1 tablespoon lemon juice
1 egg
½ teaspoon salt
½ cup milk

Mince fish, removing skin, etc. Soak crumbs in milk until soft. Mix fish and crumbs, add seasonings and beaten egg. Pack in greased moulds and bake in a pan of water until firm and delicate brown. Unmold and serve with peas or white sauce. (Use cornstarch in thickening white sauce.)

RYE AND CORN MUFFINS.

2 cups Indian meal
1 cup rye meal
2 cups sour milk
¼ cup molasses
1 egg
1 tablespoon Mazola
1 teaspoon soda
¼ teaspoon salt

Mix dry ingredients, beat in sour milk and molasses. Beat thoroughly and pour into greased pans. Bake 25-30 minutes.

OATMEAL COOKIES.

1½ cups brown sugar
2 cups rye flour
2 eggs
1 teaspoon soda
½ teaspoon salt
¼ cup raisins
1-3 cup mazola or cotton-seed oil
2 cups dry oatmeal
2 teaspoons cream of tartar
½ teaspoon cinnamon
¼ cup nuts

Mix dry ingredients. Beat egg until light, add creamed sugar and fat. Add dry ingredients, beating thoroughly. Drop from teaspoon 1 inch apart on a greased pan. Bake in moderate oven.

The pupils of Dr. Marian Weston prepared numerous graphic exhibits to show what we should save and their substitutes. Edible mushrooms and algae and herbs for greens were suggestive.

Dialogues appropriate for grade pupils were written for the occasion by Miss Frances Saville.

Food Lessons.[1]

IDA S. HARRINGTON, DIRECTOR OF HOME ECONOMICS FOR STATE OF RHODE ISLAND.

Success in the Food Conservation campaign depends on wider cooperation than we have yet brought about. The housewives alone cannot solve the problem. They must enlist the services of the men, the boys and girls, and most of all the children. Children are, of all people, the easiest to interest. All it needs is to let them have a finger in the pie. One of the problems we are trying to work out is the making of acceptable war breads, and, having made them, to enlist the willingness of our household to eat the product. No surer way of capturing the children's interest can be found than to let them make a loaf of war bread, nor does this require domestic science equipment. The teacher and her class may find inspiration in making an imaginary loaf.

First explain to the children that bread making is really gardening on a very small scale. We sow a crop, the yeast plant, in a field (the dough) which must furnish all the essentials for growth, that is warmth, moisture, air, food, and room to grow. The yeast cake, which is to make our crop, is composed of a large number of very tiny plants all crowded together and having been put to sleep by taking from them all, or nearly all, of their required moisture. Two things are needed before they can work their magic. First they must be separated, like children in a school room. The little plants will not do good work when their heads are crowded close together. Such a group means mischief, not work, as every teacher knows. Next they must have water added to them. A very good illustration, if not a strictly scientific one, is to show a box of Japanese water flowers crowded together and inert and put some of them into a glass of water, showing how they expand and move apart. The next illustration is to bring out how greatly flours differ in giving the yeast plant room to grow. Have the children take a half a cup each of flour or five different kinds of flour and mix each into a little ball of dough. Put these into squares of cheesecloth and wash them in bowls of water until the starch part

[1]Given before R. I. Science Teachers' Association, Jan. 12, 1918.

of the flour has been washed out. What remains in the cheesecloth will be that rubbery, stretchy substance which we call gluten and which is needed to make dough elastic. The next illustration shows how, under good conditions, the yeast plant actually does its work. Make a small lump of dough, using about a cup of flour and ¼ cup of lukewarm water in which a cake of yeast has been dissolved. Knead the little ball of dough until it is smooth and elastic. Then put it into a pint of water as warm as the hand can bear. It will sink to the bottom and show no signs of life, but as we watch it, it will gradually begin to rise in the water and in about fifteen minutes will float on the surface, a light, spongy mass, somewhat resembling a jelly fish. Having actually seen the magic "work while you watch" the process of bread making will become one of vital interest to children. It will lead naturally to their preparing first samples of dough and afterwards rolls and bread at home and bringing them in to be judged by a jury of pupils. No child who has made war bread for a competition and taken a prize will refuse to eat the prize product. Wheatless days will have no further terrors for that child.

It has often been demonstrated in other lines of work how helpful the making of exhibits is in arousing the pupils' interest. Witness the exhibits shown here today which could not have been what they are had they not been prepared with whole-hearted interest.

Finally there is a strong dramatic instinct in children which may be counted on to develop their interest in food conservation as it has done in other topics. A very successful production of a Hoover play entitled "Uncle Sam's Visit to Rhode Island" was given by the Sunday School of the Cranston Street Baptist Church recently. It brought out how small is the number of things which we are asked to save and how large the number of possible substitutes. The boy who represented White Bread was quite lost sight of by the time the various War Breads had appeared on the stage. The child who impersonated the Butter Ball sank into insignificance before the charms of Miss Beef Drippins who was adorned with a helmet promoted from the ranks of saucepans, and from which dangled streamers to simulate streams of fat.

The lesson of purpose and patriotism was driven home by the fact that no character approached Uncle Sam without saluting him and the flag. At the end of the performance the audience as

a whole gave the salute and joined in the singing of America.

While a performance like the above would require large numbers and more preparation than could be furnished in the average school, there is no lack of simple dialogues which could be used. The one appended, "Food Army Recruits", written by Miss Frances E. Saville, could be given with a minimum of preparatory work. The article entitled "The Home Guard" in the December number of the Home Economics Journal could be most successfully adapted to dialogue form. Anything that proves to children that they are important factors in the national work we have undertaken means surer cooperation now and better citizenship in the days to come.

Food Army Recruits.

BY FRANCES E. SAVILLE.

SCENE: *Family Dining Room.*

Bob. (*Reading paper*). "Another slacker caught at Glendale" (*looking up*) Say Jack, wouldn't you hate to be a slacker?

Jess. You needn't say anything, Bob Manning, you are a slacker and so is Jack.

Both. What!

Jess. Yes, you are slackers.

Jack. How are we slackers? We have not been called to be soldiers and if we were called you bet we'd go, wouldn't we, Bob?

Bob. You bet we'd go. I wish I was old enough to go right now.

Jess. Well, Miss Judson says we must all be soldiers and that is why I called you slackers for you are not answering to the call to be the kind of soldiers she told us about in school today.

Bob. What kind of a soldier is that, sis?

Jess. A soldier in the food army. Didn't Mr. Smith tell you about it in your room today?

Jack. Yes, he did tell us something about it but I didn't pay much attention.

Prue. (*much younger*) Miss Haley told us about it today, too. She said we could all join the Food Army and in arithmetic we counted up in our lesson how many pounds of sugar would be

saved in a week, if every member of our families used one teaspoonful less every day.

Bob. How much was it, Prue?

Prue. Fifteen pounds, seven ounces, and three-quarters.

Jess. And you used three spoonfuls on your oatmeal this morning, Bob, and that's why I called you a slacker.

Prue. Well I guess we are all slackers that way but I'm going to try to use less so the poor little French and Belgian children can have more.

Jack. I tell you what let's do. Let's form a Junior Food Army Corp and pledge ourselves to follow out all the rules Mr. Hoover has laid down for us.

Jess. That means less sugar on your oatmeal, Bob.

Bob. Well, I'll give it up if you'll give up your candy at recess time.

Jack. And I'll stop chewing gum and give the money to the Red Cross instead.

Prue. And I'll try to eat corn bread without finding fault, but I do hate it.

Jess. Let's all give up our toast for breakfast and eat more oatmeal instead so that will make our wheatless meal every day.

Prue. Have we got to eat Johnny cake both Wednesday and Thursday too?

Jess. No, we can have oatmeal bread, rye bread, and barley bread, as well. Miss Lathrop is going to teach us to make war bread in cooking class.

Jack. And I suppose you'll come home and make some and we'll have to eat it. Well, a man can't die for his country but once. How will this look on my tombstone? "Here lies John Manning. Died at the age of fourteen years from eating war bread. He gave his life for his country."

Bob. Well, what else must we do?

Jess. No meat on Tuesday and Friday and no pork on Saturday.

Bob. Then we can't have any baked beans for Saturday night.

Jess. Oh yes we can have them! Mr. Hoover says New England people may have pork in their beans as usual, and we can have brown bread as often as we can persuade mother to make it. It will help out our wheatless days.

Jack. Good idea, sis.

Prue. I like brown bread better than Johnny cake particularly if Mary puts raisins in it.

Jess. Yes, and we don't any of us want to be slackers in the Food Army for that is one way we can help win the war.

Bob. Of course we don't want to be slackers and you won't have a chance to call me a slacker again on that score.

Jack. Nor I. I'll eat war bread if it does kill me.

Jess. Since we can't go to fight let's all do our best right here at home by making the best of our war food for we have so much more than the poor children in France and Belgium and what we save goes to them.

Prue. And teacher says if we all save a little there will be plenty for us and them too.

Bibliography of General Science for 1917

W. L. EIKENBERRY, UNIVERSITY OF KANSAS.

A year ago the writer published in General Science Quarterly a bibliography of general science to the end of 1916. At that time a request was made for corrections and additions to the list. No corrections and few additions have been sent in.

The present contribution is intended to bring the bibliography down to the end of 1917. All articles known to the writer and dealing directly with general science have been included. It is not supposed, however, that everything published has been found. It is particularly difficult to keep track of local and state publications. The writer will therefore take it as a courtesy if citations or separates are sent to him, either of articles published heretofore and not listed or of articles to be published in the future.

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Color Blindness.

PAUL AMMON MAXWELL, AVALON, PA.

THE PROJECT. The human eye offers many interesting projects for use in general science courses, among them the project of color blindness. A thorough study of this subject will not only be useful, but also attractive to the majority of pupils.

Probably the best method of procedure is to first make clear the normal processes of color vision in order to then explan the abnormal condition which makes one insensible to certain colors. Such a plan will be followed in this discussion.

THE MECHANISM OF THE EYE. Most high school pupils are familiar with the mechanism of the camera and it is therefore advisable to consider the eye as a spherical camera having a shutter, diaphram, lens, plate, etc. When light enters the pupil of the eye it is refracted by the lens and brought to a focus upon the inner wall of the eye-ball which, like the plate of a camera, is sensitive to light. This inner wall or "retina" of the eye is made up of thousands of minute structures, "rods" and "cones", each of which is the terminus of a nerve fibre leading from the optic nerve. It is these rods and cones which receive the stimuli in the form of light and are so affected that sensations of sight result. The rods function in forming sensations of white, black or gray; the cones in forming color sensations.

THE NATURE OF LIGHT. In order to understand the physical nature of light a sharp distinction must be made between light as it appears to us in sensations and light as a form of energy. Light in a physical sense is a type of wave motion traveling here and there in space very much like sound and water waves. Like these

other waves light waves may vary in length and may be of different vibration rates. For instance it is known that light waves vary in length from about 300 to 2,000 millionths of a millimeter. The human eye is sensitive to all waves between 393 and 759 millionths of a millimeter in length, waves outside of these limits not producing sensations of sight.

VISUAL SENSATIONS. Sunlight and artificial white light are mixtures of waves of various lengths. If sunlight falls upon an object which is capable of reflecting all wave lengths from it, the object appears white or gray when the light enters the eye. If the object, however, only reflects light waves of certain lengths to the eye, absorbing the rest, it is said to have color. Each particular wave length produces a particular hue.

There are thus two aspects of visual sensations which must be treated separately; the chromatic or color aspect in which the various hues are the center of interest and the achromatic or black-white aspect in which the relative brightness of objects is considered. In explaining the color aspect, psychologists assert that there are but four primary hues; or better, two pair of primary hues which are red-green and yellow-blue. There is a particular

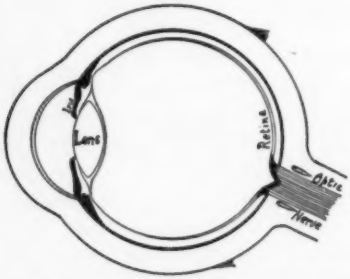

Fig. 1. The Human Eye.

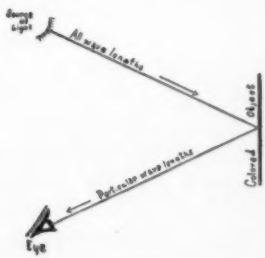

Fig. 2. Color Sensation by Reflected Light.

type of cone in the retina for each pair. When red light enters the eye, the red-green cones, are stimulated and a chemical action is set up producing the corresponding red sensation. If green light enters the eye, the same red-green cones are stimulated, but the action is in the reversed direction. The blue-yellow cones function in exactly the same manner.

The question now arises as to how the secondary or mixed hues are produced. A study of figure (3) will answer this. It is

known that when red and yellow light waves are mixed and the red and yellow actions in the cones are thereby aroused simultaneously, intermediate sensations such as orange result. But a similar sensation may be produced by light waves of a certain length. Now the red reaction is aroused by light waves of about six hundred (600) to seven hundred (700) millionths of a millimeter and the yellow reaction by waves from five hundred (500) to six hundred and fifty (650) millionths of a millimeter in length. Thus, the orange sensation may be produced by a mixture of waves varying from five hundred (500) to seven hundred (700) millionths of a millimeter, or by particular waves between six hundred (600) and six hundred fifty (650) millionths of a millimeter which act upon both types of cones. In a similar way, if the green and yellow or the green and blue reactions are produced simultaneously, intermediate hues result. In order to produce hues between red and blue, such as purple, the two types of waves must of course be mixed.

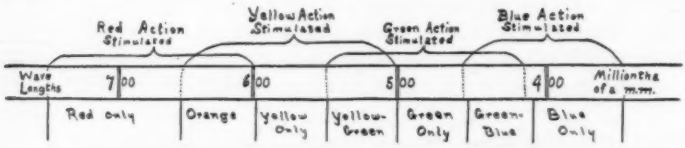

Fig. 3. Action of Light Waves Upon the Cones.

The best way to mix colors is by the use of the color mixer or the color top, which are mechanisms for rotating two or more segments of colored paper so rapidly that light is reflected to the eye from all segments at practically the same time. If either the top or the mixer is available it will be helpful to have the pupils produce all the hues from various mixtures of the four primary ones. By adding black or white, shades and tints may also be produced. It is interesting to attempt the formation of green by mixing blue and yellow which is of course impossible, since blue and yellow light waves act upon the same cones setting up opposite actions which tend to neutralize each other. Likewise there is no sensation of color when red and green light waves are mixed. Many people must be shown this to believe it, on account of the fact that the artist obtains a green pigment by mixing blue and yellow pigments.

The achromatic or black-white aspect of visual sensation is concerned with the rods of the retina. When light of various colors

enters the eye, the four primary color reactions in the cones neutralize each other. The rods, however, are stimulated and a sensation of gray results. If an object reflects all the white light from it, a certain chemical reaction takes place in the rods and the object appears white. If no white light is reflected an opposite reaction takes place and the object appears black. When only a part of the white light is reflected to the eye, some rods react one way, others, the other way, and a sensation of gray results. Objects of particular hues usually reflect more or less white light as well as their particular sort. This produces shades and tints.

COLOR ZONES OF THE RETINA. In connection with the above theory* of visual sensations it is interesting to study the locations of the rods and the cones upon the retina. Figure 4 is a diagram of the rear hemisphere of the eye-ball. There are three retinal zones; the central zone upon the extreme rear wall of the eye; the intermediate zone bordering upon the central zone; and the outer zone next to the intermediate zone. Now both types of cones are found upon the central zone, only the blue-yellow cones upon the intermediate zone and no cones upon the outer zone. The rods

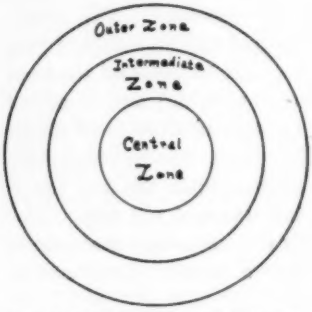

Fig. 4. The Color Zones of the Retina.

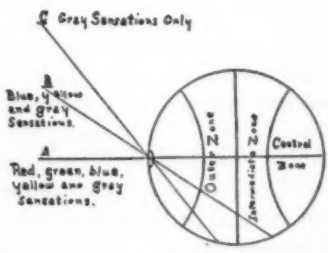

Fig. 5. Color Zones and the Field of Vision.

are scattered over all zones decreasing in abundance from the outer zone to the center of the central zone. Hence, as shown in figure (5), an object of any color such as (A) may be distinguished if it is in the center of one's field of vision and therefore reflecting light to the central retinal zone. Only objects of blue, yellow or gray or their mixed hues appear natural however in such a position as (B), for the reflected light falls in the intermediate zone

*The Herring Theory of Color Vision which is accepted by all leading psychologists.

where there are no red-green cones, with the result that red and green objects in such a position appear gray. All objects in position (C) appear gray as they reflect light to the outer zone where no cones are found. In this figure the eye is, of course, understood to be constantly focused upon point (A).

COLOR BLINDNESS. When there are no cones present in the retina of his eye a person sees everything as white, gray or black, since only the rods are stimulated. Such a condition is very rare. Absence of one type of cone, however is a common occurrence and it is usually the red-green type that is absent. To a person without red-green cones all objects appear gray that would otherwise appear red, green or any hue dependent upon the red-green cones such as purple, orange, peacock and lemon. In the rare case of blue-yellow blindness, objects that should appear blue, yellow or any mixed hue look gray. The absence of both rods and cones from the retina means total blindness.

TESTS FOR COLOR BLINDNESS. Since red-green blindness is the only common form, most tests are only concerned with this type. Following is a description of one test* which is typical. There are three standard skeins of colored wool, one green, one old rose, one dark red, and forty match skeins, all numbered. The person being examined is given the standard green skein and is told to pick out all the match skeins of the same hue. If he picks all the even numbers up to twenty (the numbers are not visible) and no others it is reasonably certain that he is not color blind since these skeins are the only ones of a green hue. The others are various colors designed to confuse the subject. As a check upon the first test a similar procedure is followed using the standard old rose. The even numbers from twenty-two to thirty are the proper matches in this case. The third standard is merely a counter check and is seldom necessary.

A very good test of this type can easily be arranged either by the teacher or the pupils, using colored paper instead of the wools.

*Holmgrens Wools.

Books Received.

Elementary Economic Geography, by Charles R. Dryer, American Book Company, 415 pp.

Commerce and industry are vital subjects in America today. This book has very successfully met the difficulties which confront young pupils (grades 7 to 9) who undertake the study. In this book the author shows a new way of using geographical material, relating environment, resources, industries and products useful to man. By far the greater part of the book is devoted to the economic geography of the United States.

Industries hold so much in common with general science and geography that general science teachers will be interested in this book. It is well illustrated with maps, line cuts, and half-tones.

General Science Book Reviews.

Experimental General Science. By WILLARD N. CLUTE. P. Blakiston's Son & Company. 304 pp.

This small volume contains 42 chapters. Thirty chapters deal with physical and chemical sciences. The chapter titles cover pretty well the usual titles in physics and the simpler ones in chemistry. The last twelve chapters deal with biological science, about half of which might be termed physiology. Among chapters dealing with life are "Living Things", "Evolution", and "Bacteria". The last nine chapters all refer to the human body and treat of "The Framework", "The Governor", "The Nourishment", "The Transporting System", "The Ventillating System", "The Covering", "The Excretion of Waste", "The Special Senses", and the "Effect of Drugs."

The book is written to meet the need of an introduction to the special sciences as well as furnish those who leave school early with a fund of "fundamental principles which are very essential to their success and happiness of life". The general style of the book is suited better to the older than to the younger pupils. The book is illustrated with numerous line cuts. There is a very good list of practical questions at the chapter ends, mixed with these questions are numerous suggestive experiments which pupils ought to perform either in school or at home.

Science for Beginners. By DELOS FALL. World Book Company, 382 pp., 34 chapters.

The opening chapters of this book discuss with the pupil in a rather unique and pleasing way how he may develop a scientific attitude toward things. This is followed by "Matter", "Properties and

Changes in Matter", "Oxygen", "Hydrogen", and "The Study of Water". Among the chapter titles which entice you to read are "A Pinch of Salt", "A Cake of Soap", "A Loaf of Bread", "The Limestone Story", "Aids to our Work". The pupil is given an introduction to minerals, rocks, and to the soil. The potato takes a chapter to itself. Other chapter titles more commonly found in texts are "The Study of the Air", "Weather", "Matter and Motion", "Sound", "Heat", "Temperature", "Light", "Electricity", "Work and Energy".

No seventh or eighth grade pupils can fail to be interested in this book. It is written in a style which appeals to young pupils. Illustrations which are real pictures are used instead of diagrams. Although there is no connecting organization running through the book many chapters grouped together are closely related and give as much organization of matter as young pupils need.

Many exercises are suggested. These may be demonstrated or performed individually. Some of them can be done as home experiments. True to its title the book is an admirable one in "science for beginners."

General Science. By CHARLES H. LAKE. Silver, Burdett & Co., 438 pp.

The book is divided into twenty-four chapters. The first chapter deals with the earth as a heavenly body. The next three on matter, energy, and machines, give the simpler principles of physics relating to these subjects. In the chapters on atmosphere and water there are brought together from various fields of science many important facts and principles. Heat and weather receive the attention which such important subjects require. In the discussion of megnetism and electricity the author fearlessly introduces the pupil to electrons. Sound and light are briefly treated. The subjects fuels, common compounds, soils and drainage complete the physical science treatment and lead to the last six chapters which deal on life of the earth. These last chapters deal with plants, animal life, man's place in nature, foods and nutrition and community sanitation.

The book shows an attempt at organization in so far as the matter in each chapter is more or less related to previous chapters. This will be welcomed by many teachers. From a science standpoint, the work is well done. The material covered furnishes a substantial foundation for future science work or for general science purposes. The book is rather advanced for seventh and eighth grades but will serve for ninth and first year high school grades. The use of questions at the chapter ends is a good feature, but the omission of an index is unfortunate.

The book is very attractive in appearance and is very well illustrated with half-tones and line cuts. There are seventy-nine experiments in fine print. These are suitable for class demonstration and in some cases for home experiments.

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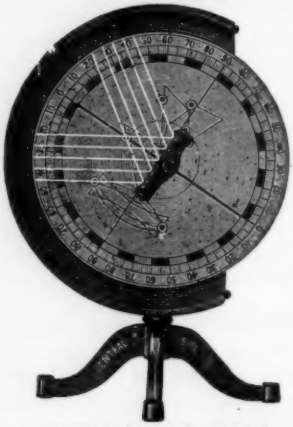

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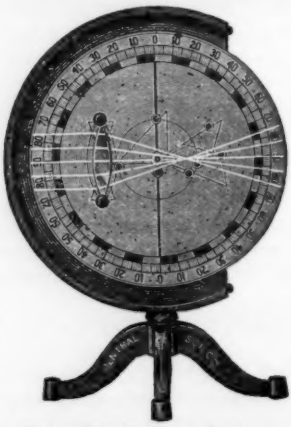

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